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(54) **IMAGE SENSING METHOD AND IMAGE SENSING APPARATUS**

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(51) **Int. Cl.**
  G06F 3/042   (2006.01)
  G06F 3/041   (2006.01)
(52) **U.S. Cl.**
  CPC *G06F 3/042* (2013.01); *G06F 3/0416* (2013.01); *G06F 3/0428* (2013.01)
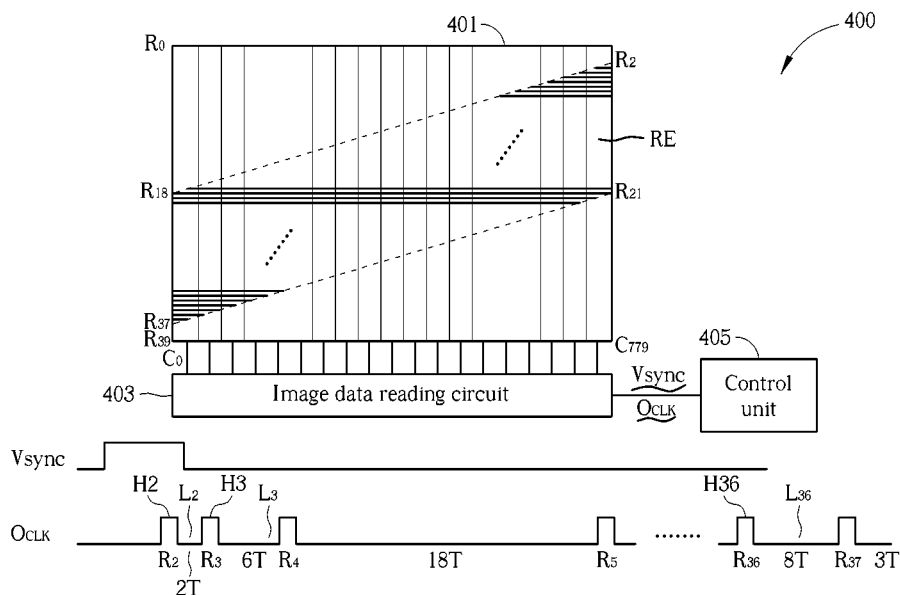(58) **Field of Classification Search**
  CPC G06F 3/042; G06F 3/0416; G06F 3/0428
  See application file for complete search history.

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(57) **ABSTRACT**

Disclosed is an image sensor comprising: an image sensing unit array, for sensing an object and comprising a plurality of image sensing units arranged in a sensing matrix with M rows and N columns; an image data reading circuit, for reading and outputting image data caught by at least part of the image sensing units; and a control unit, for controlling numbers and locations of the image sensing units for each row or each column, from which the image data reading circuit reads the image data; for computing a read region that is in the image sensing unit array and corresponds to the object; and for controlling the image data reading circuit to read at least part of the image data of the column or the row. The part of the column or the row, which is read, comprises the read region.
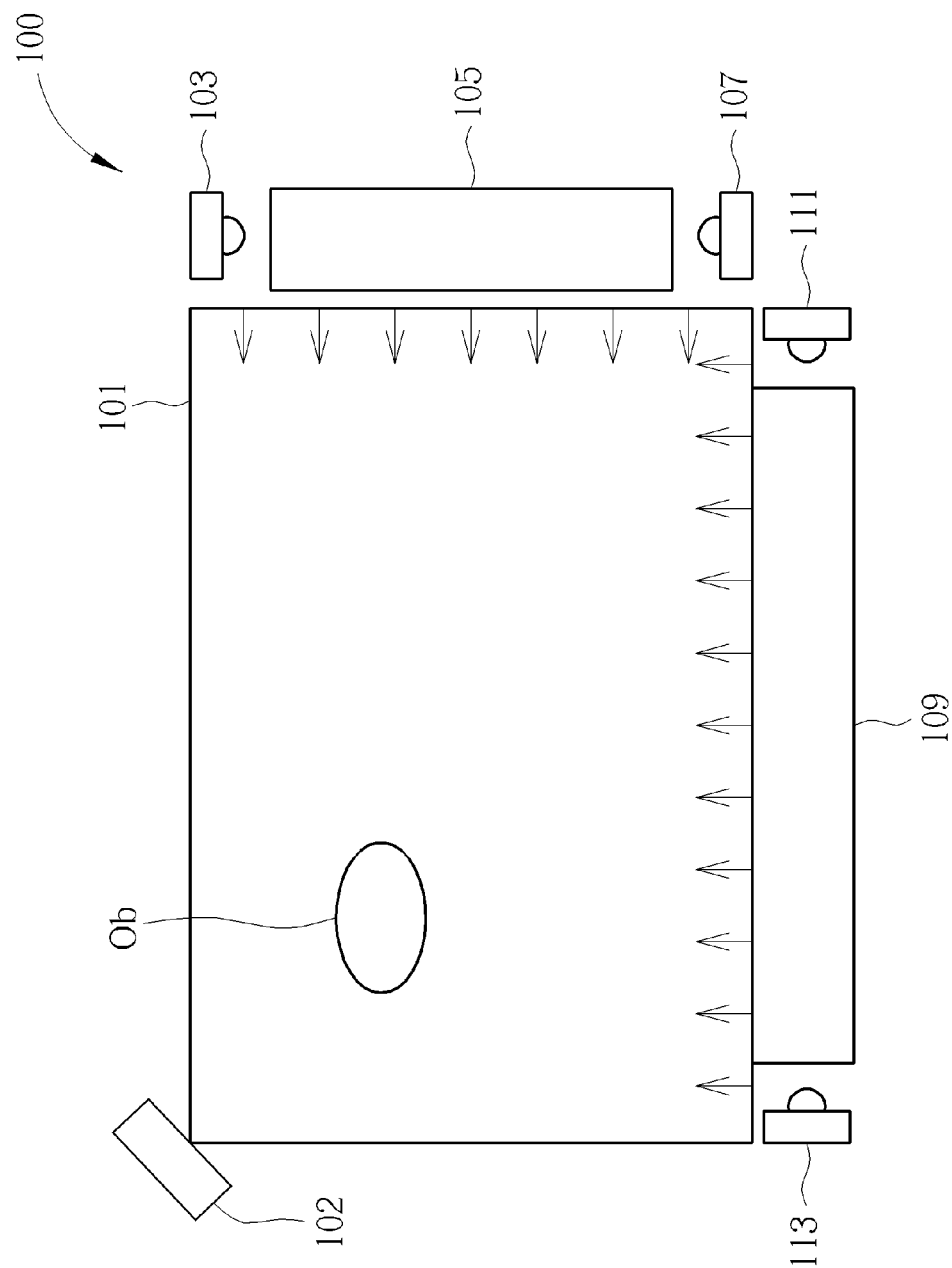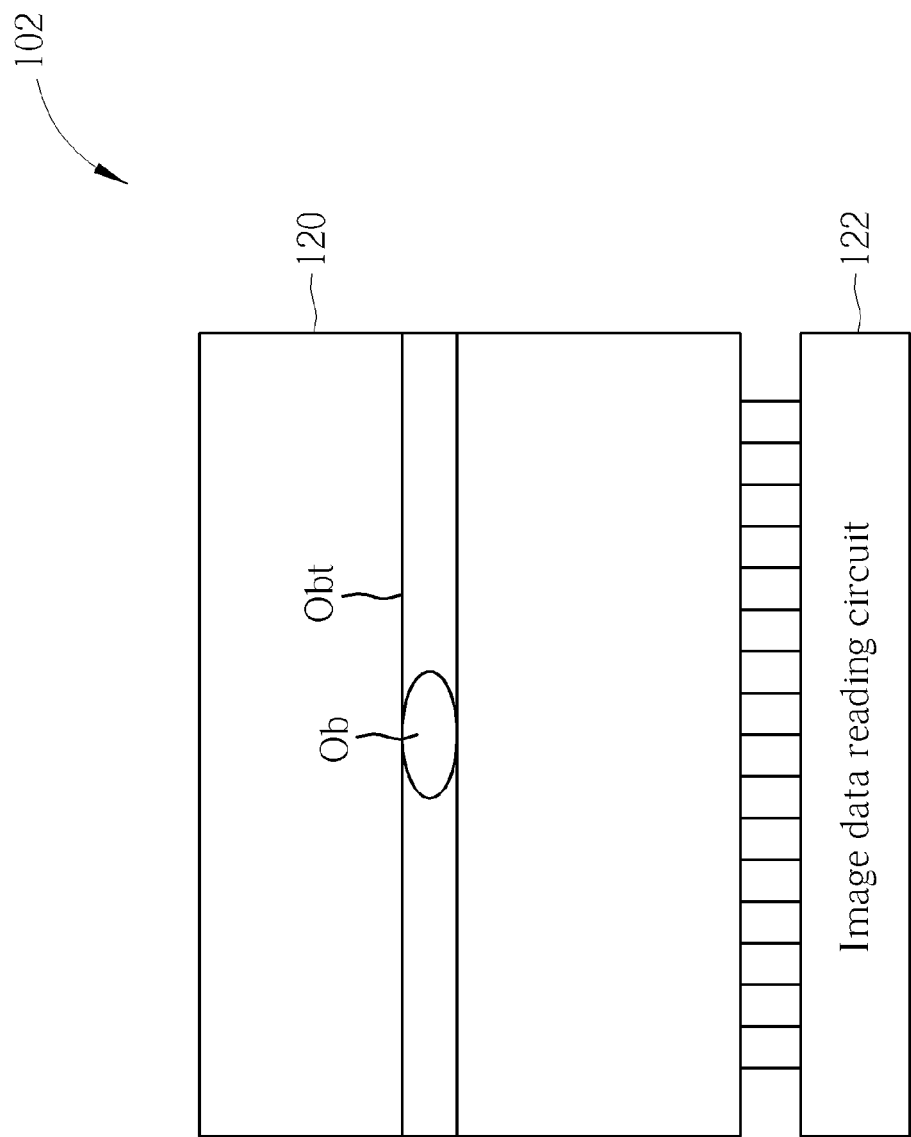
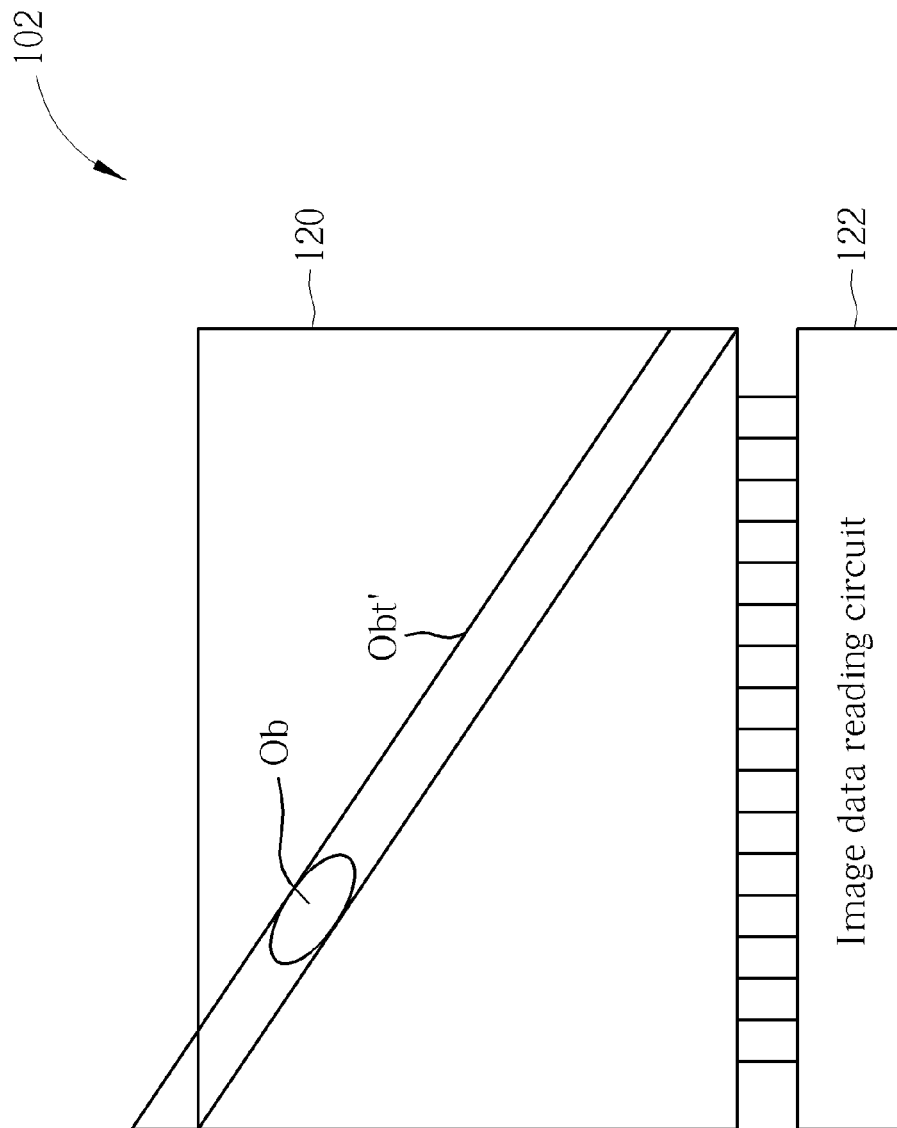**10 Claims, 11 Drawing Sheets**

FIG. 1 PRIOR ART

102

120

Ob

Obt

122

Image data reading circuit

FIG. 2 PRIOR ART

102

120

Ob

Obt'

122

Image data reading circuit

FIG. 3 PRIOR ART

FIG. 4

FIG. 5

400

401

R_0
R_2

R_{18}

R_{21}

RE

R_{37}
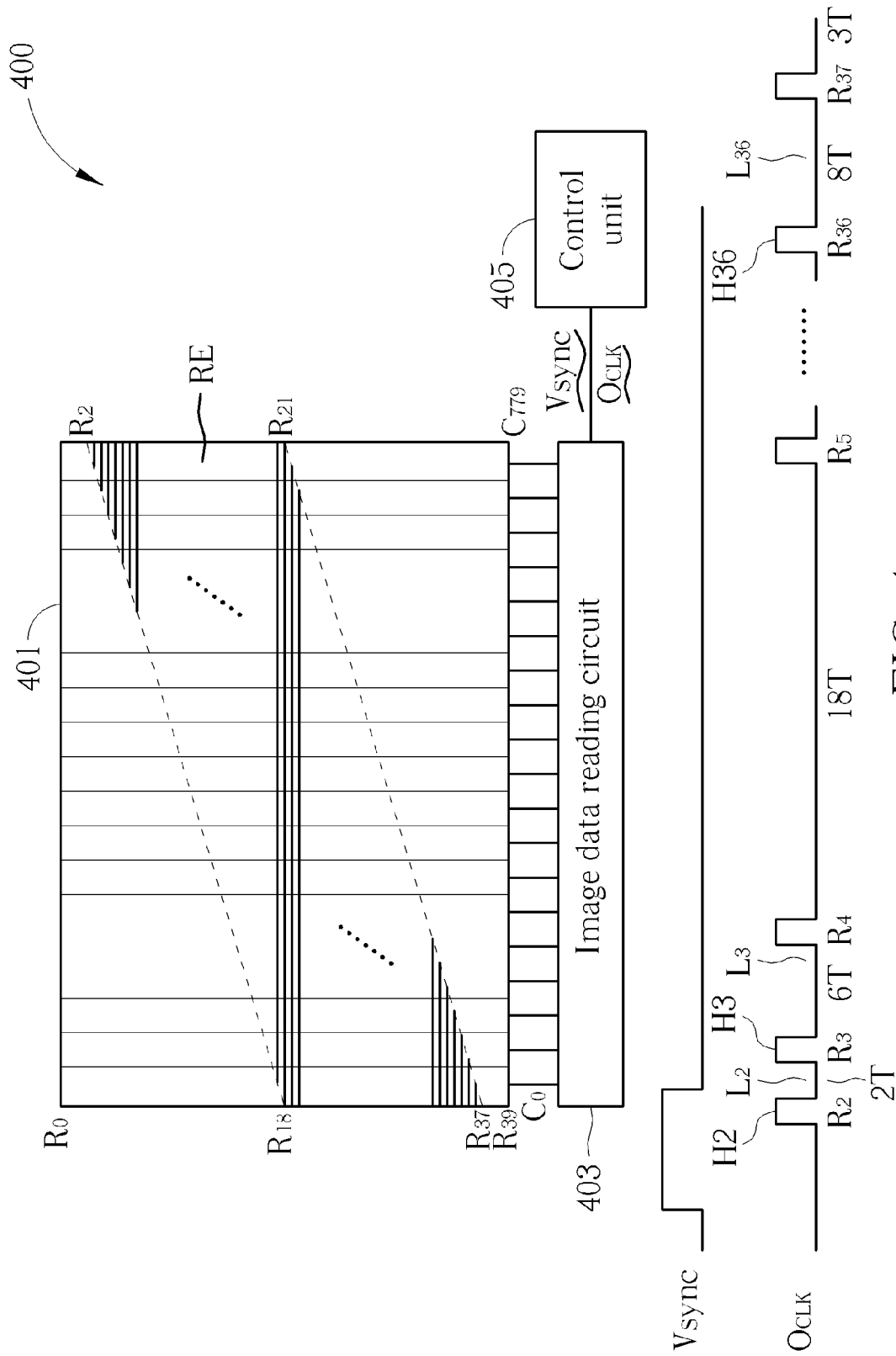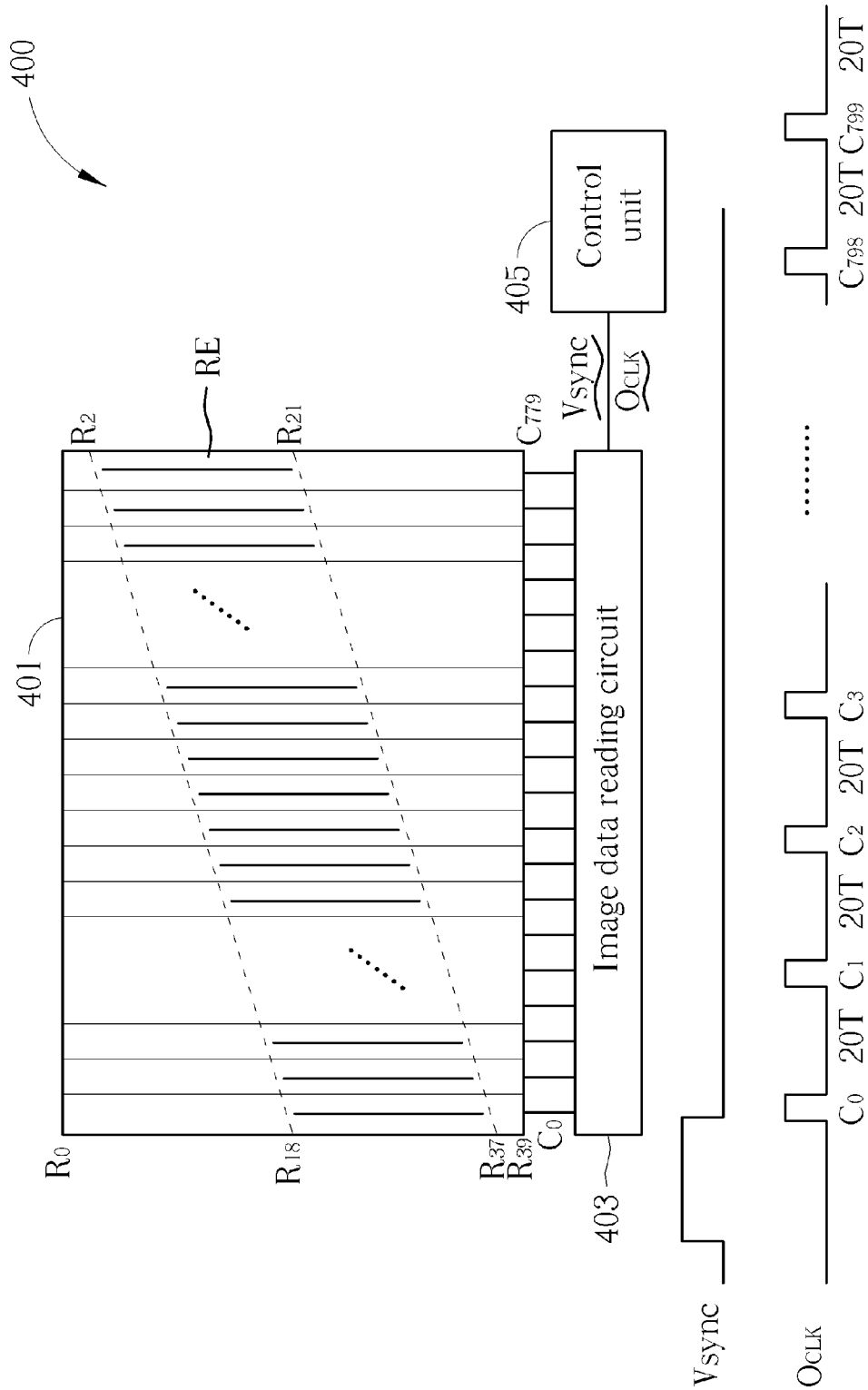R_{39}

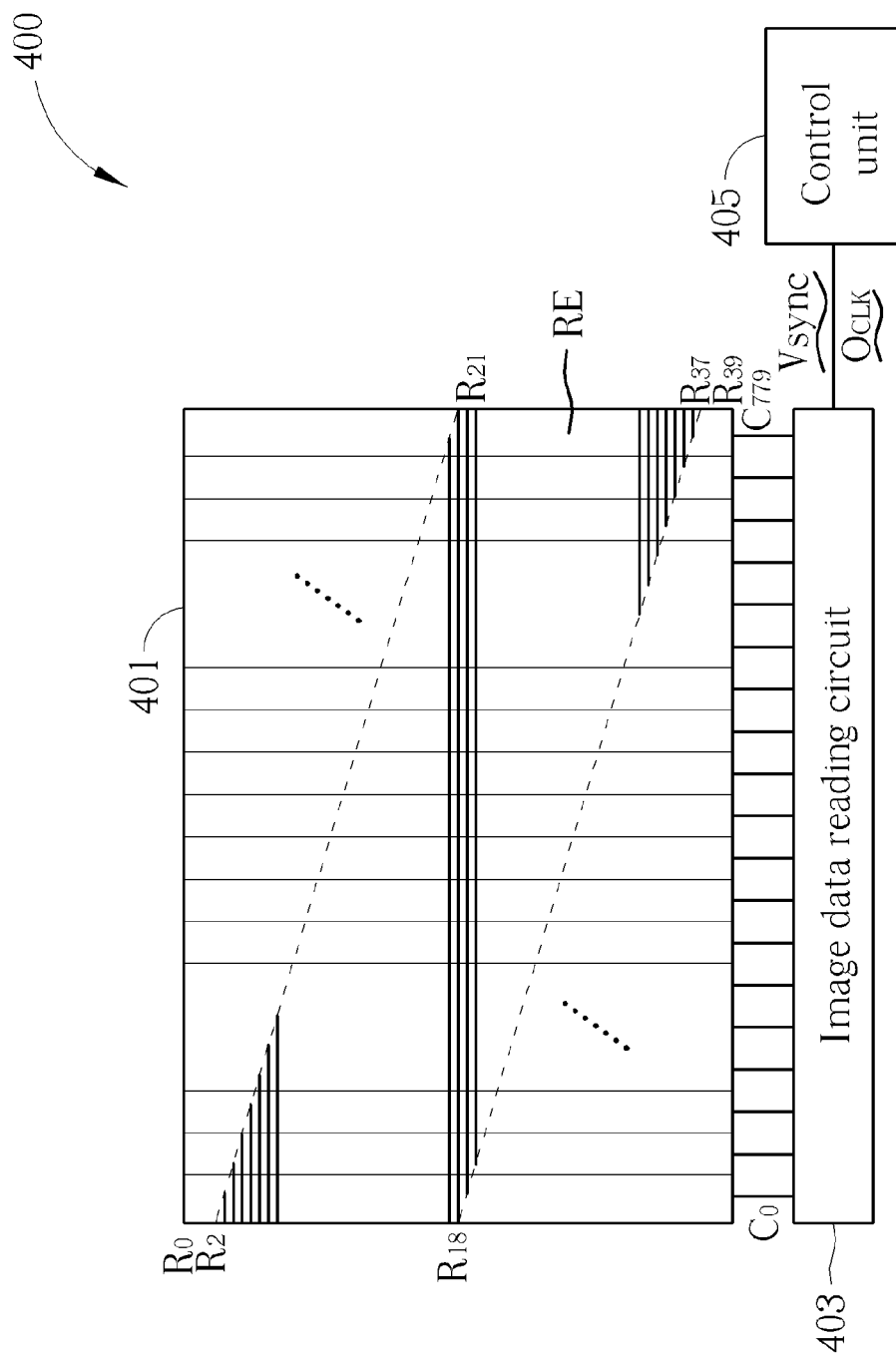C_{779}

C_0

403

Image data reading circuit

Vsync

Q_{CLK}

405

Control
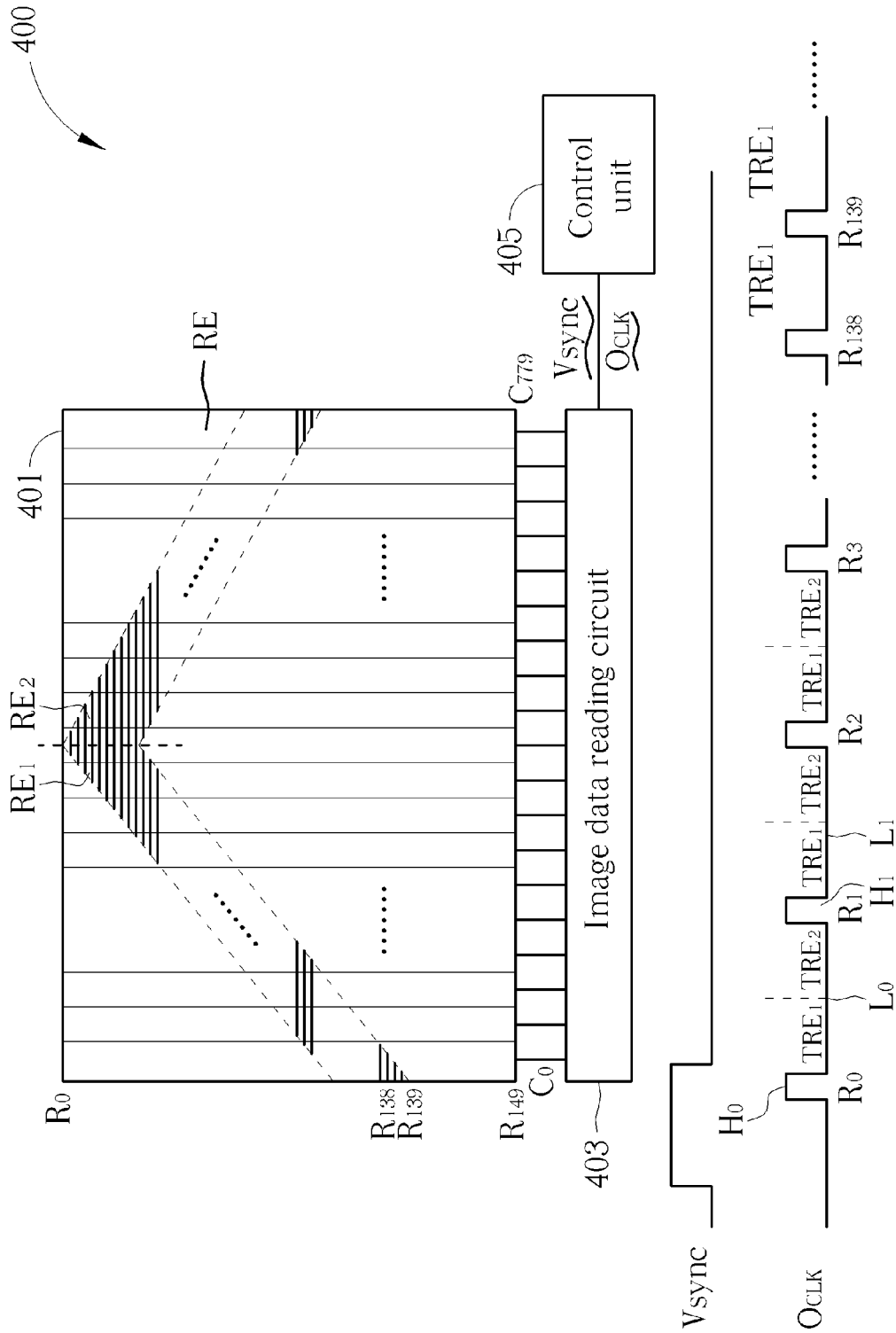unit

FIG. 6

FIG. 7

FIG. 8

FIG. 9

FIG. 10

Compute a read region, which
is for sensing an object and is
in the image sensing unit
array comprising a plurality
of image sensing units
arranged in a sensing matrix
with M rows and N columns

~1101

Read at least one part of the
column or the row, wherein
the part of the column or
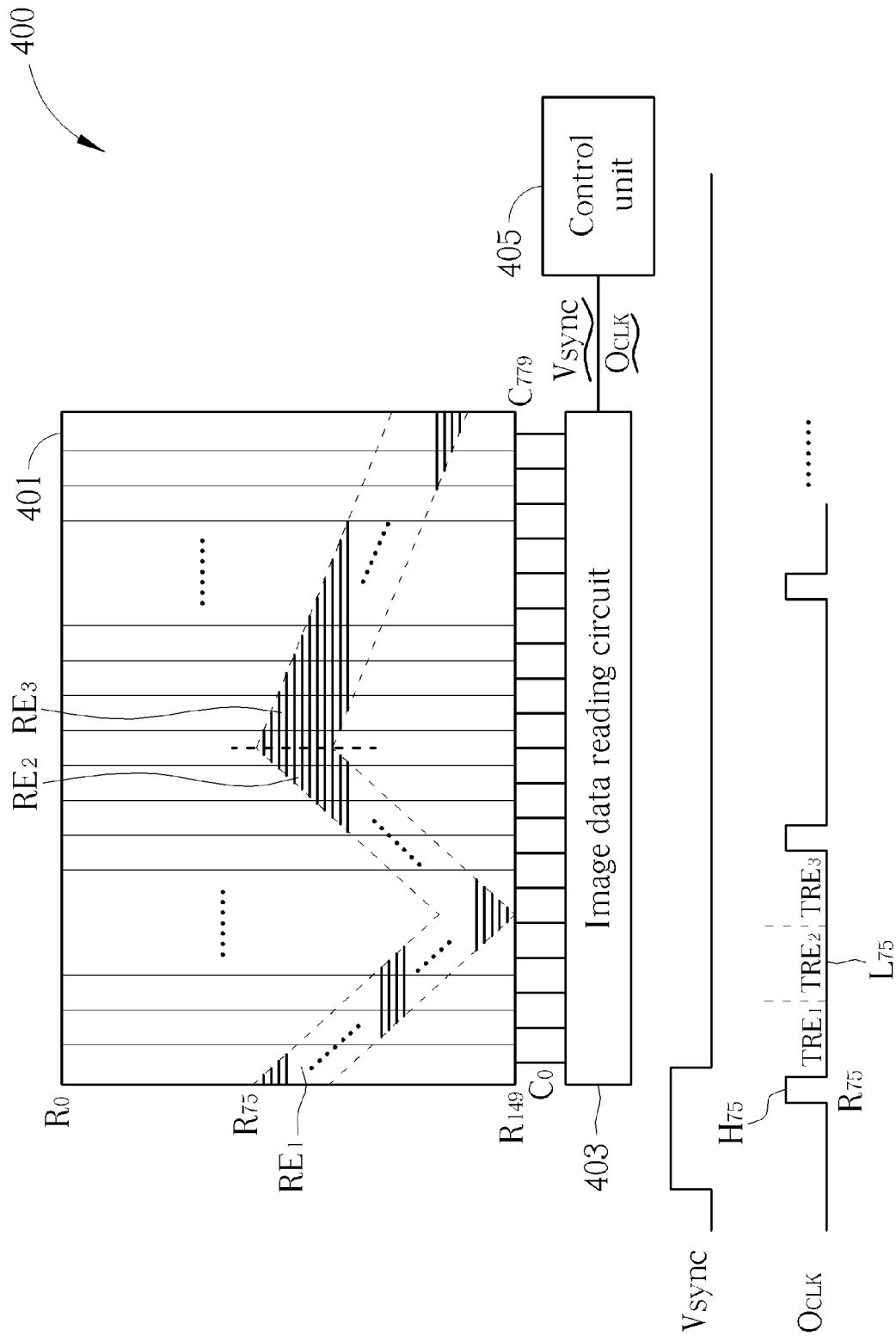the row, which is read,
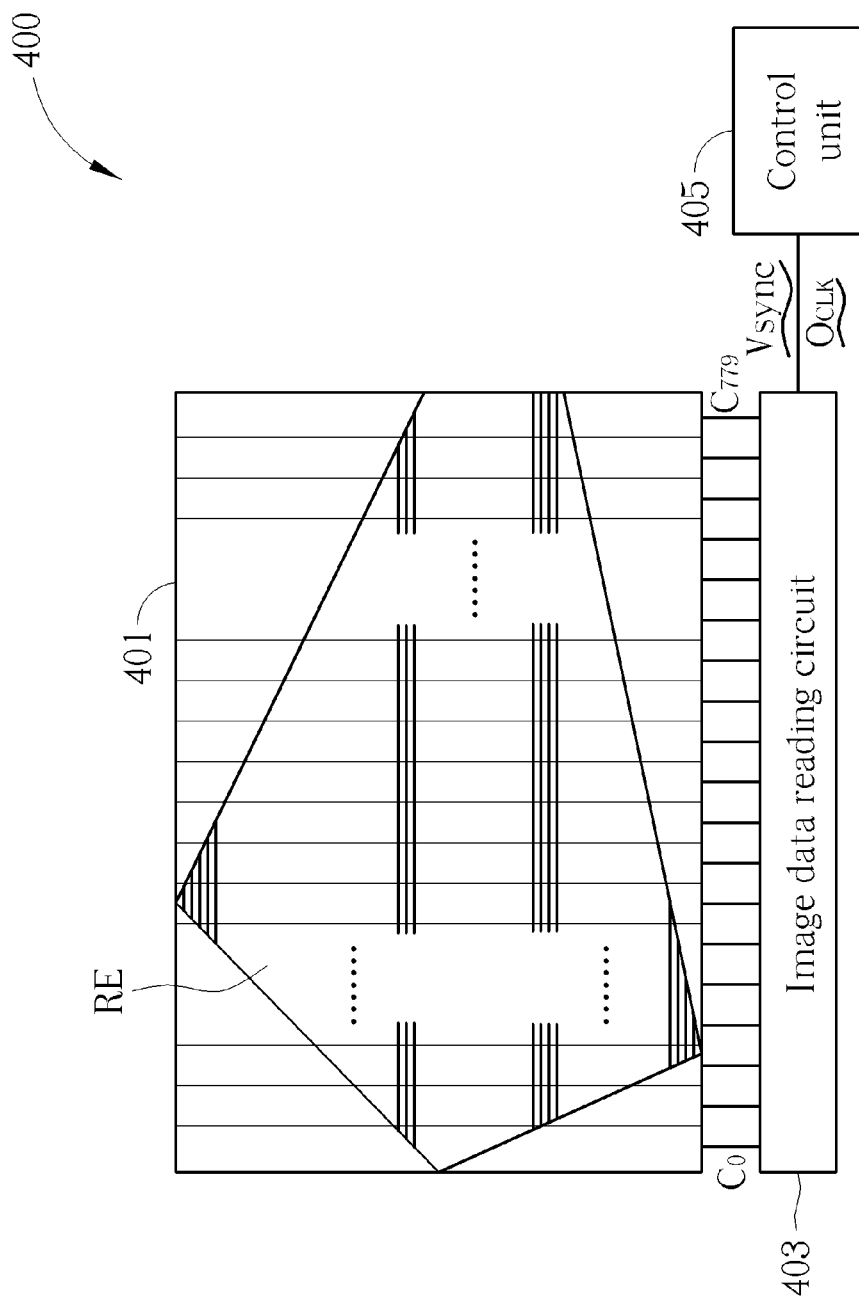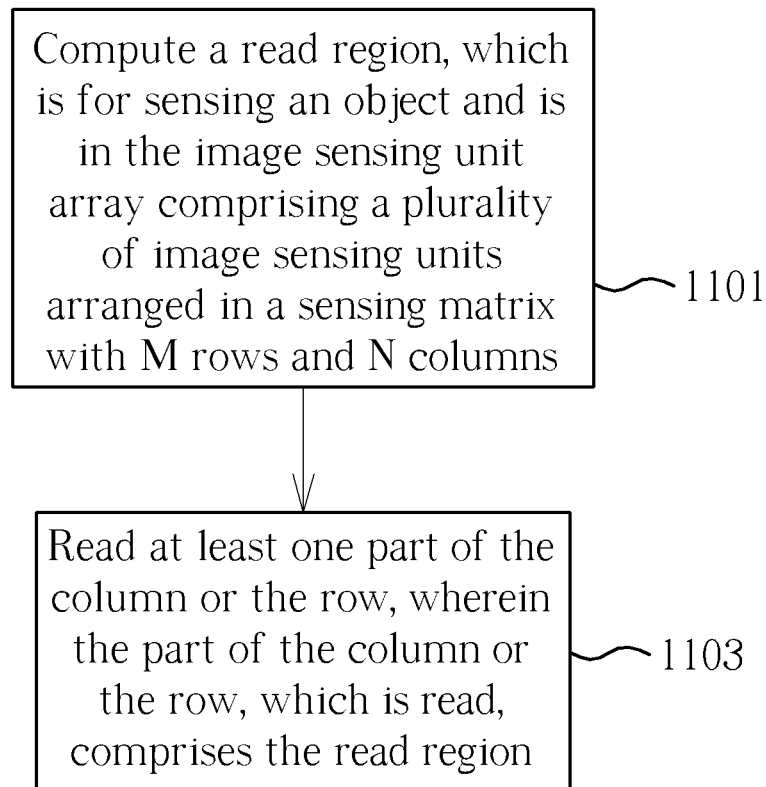comprises the read region

~1103

FIG. 11

IMAGE SENSING METHOD AND IMAGE SENSING APPARATUS

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to an image sensing method and an image sensor, and particularly relates to image sensing method and an image sensor which can read image data from read regions with different shapes.

2. Description of the Prior Art

FIG. 1 is a schematic diagram illustrating a prior art optical touch control apparatus. As shown in FIG. 1, the optical touch control apparatus 100 comprises a touch control panel 101, an image sensor 102, light guiding devices 105, 109 with bar shapes and photo diodes 103, 107, 111, 113. The light guiding devices 105, 109 are provided at two sides of the touch control panel 101. The photo diodes 103, 107, 111, 113 are respectively provided at the endings of the light guiding devices 105, 109, to project light to the touch control panel 101 via the light guiding devices 105, 109. The image sensor 102 is provided opposite to the light guiding devices 105, 109. If an object Ob (ex. user's finger) moves on the touch control panel 101, the image sensor 102 can sense the projection image for the object image Ob, which means the dark region generated via shading light from the light guiding devices 105, 109 by the object Ob. The location for the object Ob is computed accordingly.

The image sensor 102 can comprise a pixel array 120 and an image data reading circuit 122, as shown in FIG. 2 and FIG. 3. The data reading circuit 120 senses the image and generates the image data. The image data reading circuit 122 reads the image data generated by the pixel array 120. Please refer to FIG. 2, which illustrates a projection image for an ideal object track on the image sensor 102 in FIG. 1. The ideal state here means no error or skew occurs when the touch control panel 101 and the image sensor 102 are fabricated. In such case, the light guiding devices 105, 109 present a rectangular bright background on the pixel array 120 as shown in FIG. 2. The movement for the object on the touch control panel generates dark region to the bright background, therefore the bright background can be regarded as a possible moving track for the object Ob. However, practically the product has assembly tolerance, such that the error or skew may occurs when the touch control panel 101 and the image sensor 102 are fabricated. In such case, the moving track Obt' for the object Ob on the pixel array 120 is an oblique parallelogram as shown in FIG. 3.

The image data reading circuit 122 always reads the data of the pixel array 120 row by row or column by column. Therefore, the example in FIG. 2 only needs to read image data of the pixel rows in the moving track Obt to acquire the location of the object Ob. However, the example in FIG. 3 needs to read image data of all pixel rows or all pixel columns to acquire the image data for all pixels in the moving track Obt' to acquire the location of the object Ob. In such case the image data reading circuit 122 needs much time to read the image data.

SUMMARY OF THE INVENTION

Therefore, one purpose of the present invention is to provide an image sensing method and an image sensor, which can read the image data of the read region via reading the image data for only part of the rows or the columns, to decrease data reading amount of the image data.

One embodiment of the present invention discloses an image sensor, which comprises: an image sensing unit array, for sensing an object and comprising a plurality of image sensing units arranged in a sensing matrix with M rows and N columns; an image data reading circuit, for reading and outputting image data caught by at least part of the image sensing units; and a control unit, for controlling numbers and locations of the image sensing units for each row or each column, from which the image data reading circuit reads the image data; for computing a read region that is in the image sensing unit array and corresponds to the object; and for controlling the image data reading circuit to read at least part of the image data of the column or the row. The part of the column or the row, which is read, comprises the read region.

Still another embodiment of the present invention discloses an image sensing method, comprising: computing a read region, which is for sensing an object and is in the image sensing unit array comprising a plurality of image sensing units arranged in a sensing matrix with M rows and N columns; and reading at least one part of the column or the row, wherein the part of the column or the row, which is read, comprises the read region.

In view of above-mentioned embodiments, the present invention can read the image data of the read region via only part image data for rows or columns. Therefore, it does not need to read all regions for the pixel array, or to read a region that is larger than the read region, thereby the time for reading the image data can be decreased. Additionally, the present invention provides a mechanism to select the column-wise method or the row-wise method to read the image data based on the numbers of rows and columns. By this way, the operation for reading the image data can be more efficiency.

These and other objectives of the present invention will no doubt become obvious to those of ordinary skill in the art after reading the following detailed description of the preferred embodiment that is illustrated in the various figures and drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic diagram illustrating a prior art optical touch control apparatus.

FIG. 2 is a schematic diagram illustrating a projection image for an ideal object track on the image sensor in FIG. 1.

FIG. 3 is a schematic diagram illustrating a projection image for an object track having error on the image sensor in FIG. 1.

FIG. 4 to FIG. 10 are schematic diagrams illustrating image sensors according to different embodiments of the present invention.

FIG. 11 is a flow chart illustrating an image sensing method according to an embodiment of the present invention.

DETAILED DESCRIPTION

FIG. 4 to FIG. 10 are schematic diagrams illustrating image sensors according to different embodiments of the present invention. As shown in FIG. 4, the image sensor 400 comprises a pixel array 401, an image data reading circuit 403 and a control unit 405. The image sensing unit array 401 senses an object (ex. a finger) and comprises a plurality of pixels arranged in a sensing matrix with M rows and N columns. The following embodiments are explained in the condition that M is smaller than N, but pleases note the N can be smaller than M. Also, the pixel array 401 can be replaced with other types of image sensing unit array, and the pixels can be replaced with the image sensing units in the image sensing

unit array. The image data reading circuit **403** reads and outputs image data caught by at least part of the image sensing units. The control unit **405** controls numbers and locations of the image sensing units for each row or each column, from which the image data reading circuit **403** reads the image data. Also, the control unit **405** computes a read region that is in the image sensing unit array and corresponds to the object (i.e. the region that the projection image of the object locates). Additionally, the control unit **405** controls the image data reading circuit **403** to read at least part of the image data of the column or the row. The part of the column or the row, which is read, comprises the read region.

Take FIG. **4** for example, the control unit **405** computes the read region RE via computing at least one read slope. For example, the pixel array **401** comprises 40 rows and 780 columns and detects that the read region starts at a nineteenth pixel row R_{18} at the left side, and starts at a third pixel row R_2 at the right side, thus a read slope can be acquired via the equation $3-19/780=-0.0205$. Also, if it is known that the read region RE contains 20 rows, such that it can be acquired that the read region ends at a 38th pixel row R_{37} at the left side, and ends at a 22nd pixel row R_{21} at the right side. By this way the read region can be obtained. The read region corresponding to the object may have an irregular shape, such that a plurality of rectangles and parallelograms can be utilized to contain the read region. Please note the rectangles and parallelograms are only for example and do not mean to limit the scope of the present invention. Many methods can be utilized to know how many rows that the read region contains. For example, the image data reading circuit **403** reads the image data according to the read clock signal O_{CLK} in FIG. **4**, thus a number of the rows that the read region RE contains can be computed according to the timing of the read clock signal O_{CLK}. Alternatively, the number of the rows that the read region RE contains can be acquired depending on the spec of the pixel array **401** or the image data reading circuit **403**. Besides computing the read slope as above-mentioned description, a background image can be caught to obtain the bright region generated by a light source. After that, one or more read regions are allocated depending on the bright region such that the read region can be formed. Please note the method for computing the read region is not limited to the above-mentioned methods. For example, a bit map can be utilized to compute the read region RE.

After getting the read region RE, the control unit **405** can accordingly read image data in the read region RE. For example, if it is computed that only two rightmost pixels of the 3rd pixel row R_2 are contained in the read region RE, the control unit **405** can control the image data reading circuit **403** to read only the two rightmost pixels of the 3rd pixel row R_2 rather than all pixels of the 3rd pixel row R_2. Similarly, if it is computed that the 1st-10th pixels from left to right of the 22nd pixel row R_{21} are not contained in the read region RE, the control unit **405** can control the image data reading circuit **403** not to read the 1st-10th pixels from left to right of the 22nd pixel row R_{21}. As above-mentioned, the image data reading circuit **403** reads the image data according to the read clock signal O_{CLK} in FIG. **4**. In one embodiment, the high level of the read clock signal O_{CLK} triggers the read operation and the image data reading circuit **403** reads the image data when the read clock signal O_{CLK} has a low level. For example, after the read operation for the 3rd pixel row R_2 is triggered by the high level of the read clock signal O_{CLK} (the time interval H_2), the image data reading circuit **403** reads the image data of the 3rd pixel row R_2 when the read clock signal O_{CLK} has low level (the time interval L_2). In FIG. **4** the symbol **2T** marked at the low level at which the image data of the 3rd pixel row R_2 is

read indicates image data of two pixels are read. Similarly, after the read operation for the 37th pixel row R_{36} is triggered by the high level of the read clock signal O_{CLK} (the time interval H_{36}), the image data reading circuit **403** reads the image data of the 37th pixel row R_{36} when the read clock signal O_{CLK} has low level (the time interval L_{36}). In FIG. **4** the symbol **8T** marked at the low level at which the image data of the 37th pixel row R_{36} is read indicates image data of eight pixels are read. However, the above-mentioned operation can be reversed (i.e. triggered by a low level and read image data at a high level). Besides, the read clock signal O_{CLK}, the image data reading circuit **403** can further refer to a vertical sync signal V_{sync}. For example, the read operation is performed when the vertical sync signal V_{sync} has a low level.

Many mechanisms can be applied to the read operation such that the image data reading circuit **403** can only read the image data from desired pixels rather than all the pixels. For example, the patent application with a publication number US 2010/0295980 has disclosed a mechanism that the image data reading circuit **403** utilizes at least one multiplexer to read the image data from desired pixels. Such mechanism can be applied to the present invention, but not limited.

In the embodiment of FIG. **4**, the image data in the read region RE is read by row-wise. The read region RE in FIG. **5** has the same size as which in FIG. **4**, but the image data in the read region RE is read by column-wise. As shown in FIG. **5**, the image data reading circuit **403** is triggered by the high level of the output clock signal O_{CLK} when the vertical sync signal V_{sync} has a low level, and reads the image data of pixel columns C_0-C_{799} when the output clock signal O_{CLK} has a low level. The numbers for the pixel which are read in each pixel column in the read region RE in FIG. **5** are all 20, since the read region RE is a parallelogram. The image data of the read region RE can be read by row-wise or column wise depending on different requirements. As above-mentioned, the pixel array **401** is a sensing matrix with M rows and N columns. Therefore, in one embodiment, the control unit **405** controls the image data reading circuit **403** to read the image data in the read region RE by row-wise if the M is smaller than N. The control unit **405** controls the image data reading circuit **403** to read the image data in the read region RE by column-wise if the M is larger than N. Either the row-wise method or the column-wise method needs a synchronizing signal to trigger, for example, the H_{sync}, but it may changes to V_{sync} depending on the situations. Therefore, more row or columns are read, more synchronizing signals are needed, such that more time is needed to perform the read operation. Accordingly, the column-wise method needs less synchronizing signals if M is larger than N (i.e. the number of rows is larger than the number of columns). For example, if M=1000 and N=100, the row-wise method needs 1000 synchronizing signals, but only **100** synchronizing signals are needed for the column-wise method. Thereby the image data reading circuit **403** can use less times of read operations to read the image data in the read region RE such that the read time can be saved. By this way, less time is needed to read each frame, thus the frame rate for image processing can be increased.

Besides the parallelograms in FIG. **4** and FIG. **5**, the read region can be other shapes. For example, a parallelogram with other slopes, a V shape, an inverted V shape, a polygon with K sides, wherein the K is a positive integer larger than 3. That is, besides the parallelogram, the V shape, and the inverted V shape, the read region can be other regular or non-regular polygons (ex. quadrangle, pentagon, hexagon), which will be described in the following description. In the embodiment of FIG. **6**, the read region RE is also a parallelogram, but the slops for the upper edge and the bottom edge are opposite to

which of the parallelogram in FIG. 4 and FIG. 5. In the embodiment of FIG. 6, the mechanism that the control unit 405 utilizes to compute the read region RE and the mechanism that the image data reading circuit 403 utilizes to read image data of desired pixels are the same as which for above-mentioned embodiments, thus are omitted for brevity here. In the embodiment of FIG. 7, the read region is an inverted V shape with a first read region RE_1 and a second read region RE_2. Similar with the above-mentioned embodiment, the control unit 405 controls the image data reading circuit 403 to read the image data in the read regions RE_1, RE_2 when the read clock signal O_{CLK} has a low level. The control unit 405 separates each low level region of the read clock signal O_{CLK} to a first read region time interval TRE_1 and a second read region time interval TRE_2. The image data reading circuit 403 reads image data for the pixels of the first read region RE_1 in the first read region time interval TRE_1, and reads image data for the pixels of the second read region RE_2 in the second read region time interval TRE_2. If the control unit 405 computes the read region via computing the read slope as above-mentioned description, more than one read slops must be computed. For example, at least one first read slope can be computed to define the first read region time interval TRE_1, and at least one second read slope can be computed to define the second read region time interval TRE_2.

In the embodiment of FIG. 7, the image data reading circuit 403 reads image data for a single pixel row in a single period of the read clock signal O_{CLK}. The single period here comprise the high level time interval for triggering and the low level time interval for reading data. For example, the read clock signal O_{CLK} has a high level in the time interval H_0, to trigger the reading operation for the pixel row R_0. Besides, the read clock signal O_{CLK} has a low level in the time interval L_0, in which the image data of the pixel row R_0 is read. The single period of the read clock signal O_{CLK} comprises the time interval H_0 and the time interval L_0. Similarly, the time interval H_1 for triggering the reading operation for the pixel row R_1 and the time interval L_1 in which the image of the pixel row R_1 is read form a single period of the read clock signal O_{CLK} as well. The image data reading circuit 403 reads image data for a single pixel row in a single period of the read clock signal O_{CLK}. For example, in the single period comprising the time intervals H_0 and L_0, the image data reading circuit 403 reads the image data for the pixel R_0 in the first read region RE_1 in the first read region time interval TRE_1, and reads the image data for the pixel R_0 in the second read region RE_2 in the second read region time interval TRE_2. Similarly, in the single period comprising the time intervals H_1 and L_1, the image data reading circuit 403 reads the image data for the pixel R_1 in the first read region RE_1 in the first read region time interval TRE_1, and reads the image data for the pixel R_1 in the second read region RE_2 in the second read region time interval TRE_2. Since the first read region RE_1 comprises the pixel rows R_{138} and R_{139} but the second read region RE_2 does not comprise the pixel rows R_{138} and R_{139}, the single period for the read clock signal O_{CLK} corresponding only comprises the first read region time interval TRE_1. The embodiment in FIG. 7 can read the image in column-wise, as above-mentioned. Also, the embodiment in FIG. 7 can select the column-wise method or the row-wise method depending on the numbers for rows and columns.

In the embodiment of FIG. 8, the read region also comprises a first read region RE_1 and a second read region RE_2, which form a read region with an inverted V shape. In FIG. 8, the operation for the control unit 405 to compute the read region and the operation for the image data reading circuit 403 to read the image data is the same as which of FIG. 7, thus

it is omitted for brevity here. In the embodiment of FIG. 9, the read region comprises a first read region RE_1, a second read region RE_2 and a third read region RE_3. In such case, the operation for the control unit 405 to compute the read region is the same as which for the embodiment in FIG. 7, but the control unit 405 needs to particularly allocate time for reading the third read region RE_3 for a single period of the read clock signal O_{CLK}. For example, the low level time interval L_{75} for reading the pixel row R_{75}. In the embodiment of FIG. 10, the read region RE is a pentagon, and the control unit 405/image data reading circuit 403 can utilize the operation described in the embodiments of FIG. 4, FIG. 5 to compute the read region and to read the image data. Please note the above-mentioned embodiments are only for example to explain the present invention, but do not meant that the scope of the present invention is limited to the read regions with the above-mentioned shapes. The above-mentioned mechanism according to the present invention can be applied to read regions with any other shape. Additionally, the above-mentioned image sensor is not limited to the optical touch control apparatus in FIG. 1, but also can be applied to any other electronic apparatus.

In view of above-mentioned embodiments, the image sensing method in FIG. 11 can be acquired, which comprises the following steps:

Step 1101

Compute a read region, which is for sensing an object and is in the image sensing unit array comprising a plurality of image sensing units arranged in a sensing matrix with M rows and N columns.

Step 1103

Read at least one part of the column or the row, wherein the part of the column or the row, which is read, comprises the read region.

Other detail characteristics can be acquired in view of above-mentioned embodiments, thus are omitted for brevity here.

In view of above-mentioned embodiments, the present invention can read the image data of the read region via only part image data for rows or columns. Therefore, it does not need to read all the pixel array, or to read a region that is larger than the read region, thereby the time for reading the image data can be decreased. Additionally, the present invention provides a mechanism to select the column-wise method or the row-wise method to read the image data based on the numbers of rows and columns. By this way, the operation for reading the image data can be more efficiency.

Those skilled in the art will readily observe that numerous modifications and alterations of the device and method may be made while retaining the teachings of the invention. Accordingly, the above disclosure should be construed as limited only by the metes and bounds of the appended claims.

What is claimed is:

1. An image sensor, comprising:

an image sensing unit array, for sensing an object and comprising a plurality of image sensing units arranged in a sensing matrix with M rows and N columns;

an image data reading circuit, for reading and outputting image data caught by at least part of the image sensing units; and

a control unit,

for controlling numbers and locations of the image sensing units for each row or each column, from which the image data reading circuit reads the image data;

for computing relations between a read region and each the row or each the column, wherein the read region in the image sensing unit array and corresponds to the object; and

for controlling the image data reading circuit to read at least part of the image data of the column or the row according to the relations;

wherein the control unit controls the image data reading circuit to read the image data of the read region in a first level region of a read clock signal;

where the read region comprises a first read region and a second read region, and the control unit separates the first level region to a first read region time interval and a second read region time interval;

wherein the image data reading circuit reads the image data for the image sensing units of the first read region in the first read region time interval, and the image data reading circuit reads the image data for the image sensing units of the second read region in the second read region time interval;

wherein, if the M is larger than the N, the image sensing units from which the image data reading circuit read the image data in a single period of the first read region time interval, and the image sensing units from which the image data reading circuit read the image data in a single period of the second read region time interval, are the image sensing units in the same row.

2. The image sensor of claim 1, wherein the control unit controls the image data reading circuit to read the image data in the read region by row-wise if the M is smaller than N; where the control unit controls the image data reading circuit to read the image data in the read region by column-wise if the M is larger than N.

3. The image sensor of claim 1, wherein the control units computes at least one read slope according to an image of the object, and computes the read region according to the read slope.

4. The image sensor of claim 1, wherein the read region is one of the following shapes: a parallelogram, a V shape, an inverted V shape, a polygon with K sides, wherein the K is a positive integer larger than 3.

5. An image sensing method, applied to an image sensing unit array comprising a plurality of image sensing units arranged in a sensing matrix with M rows and N columns, comprising:

computing relations between a read region and each the row or each the column, wherein the read region is for sensing an object and is in the image sensing unit array;

reading at least one part of the column or the row according to the relations;

reading the image data of the read region in a first level region of a read clock signal, wherein the read region comprises a first read region and a second read region;

separating the first level region to a first read region time interval and a second read region time interval;

reading the image data for the image sensing units of the first read region in the first read region time interval; and

reading the image data for the image sensing units of the second read region in the second read region time interval;

wherein, if the M is larger than the N, the image sensing units from which the image data is read in a single period of the first read region time interval, and the image sensing units from which the image data is read in a single period of the second read region time interval, are the image sensing units in the same row.

6. The image sensing method of claim 5, further comprising:

reading the image data in the read region by row-wise if the M is smaller than N; and

reading the image data in the read region by column-wise if the M is larger than N.

7. The image sensing method of claim 5, further comprising computing at least one read slope according to an image of the object, and computing the read region according to the read slope.

8. The image sensing method of claim 5, wherein the read region is one of the following shapes: a parallelogram, a V shape, an inverted V shape, a polygon with K sides, wherein the K is a positive integer larger than 3.

9. An image sensor, comprising:

an image sensing unit array, for sensing an object and comprising a plurality of image sensing units arranged in a sensing matrix with M rows and N columns;

an image data reading circuit, for reading and outputting image data caught by at least part of the image sensing units; and

a control unit,

for controlling numbers and locations of the image sensing units for each row or each column, from which the image data reading circuit reads the image data;

for computing a read region that is in the image sensing unit array and corresponds to the object; and

for controlling the image data reading circuit to read at least part of the image data of the column or the row;

wherein the part of the column or the row, which is read, comprises the read region;

wherein the read region comprises a first read region and a second read region, wherein the control units computes a first read slope and a second read slope according to the image of the object, computes the first read region according to the first read slope, and computes the second read region according to the second read slope.

10. An image sensing method, comprising:

computing a read region, which is for sensing an object and is in the image sensing unit array comprising a plurality of image sensing units arranged in a sensing matrix with M rows and N columns; and

reading at least one part of the column or the row, wherein the part of the column or the row, which is read, comprises the read region;

wherein the read region comprises a first read region and a second read region, wherein the image sensing method comprises computing a first read slope and a second read slope according to the image of the object, computing the first read region according to the first read slope, and computing the second read region according to the second read slope.

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